

THE MODEL ENGINEER



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The MODEL ENGINEER

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RETROSPECT

WITH this issue, the hundredth volume of THE MODEL ENGINEER is completed, and such an occasion cannot be allowed to pass without a thought. So many thoughts occur to us, however! Our editorial mind is crowded with them, and most of them are memories. But one stands out above all others, and it is the thought of where THE MODEL ENGINEER stands today as a result of the sympathetic understanding and the unruffled persistence of the man who made himself the friend of all readers of THE MODEL ENGINEER—Percival Marshall. Those of us who were privileged to be intimately associated with him in his work know that, while he was naturally proud of the result of his fifty years of endeavour, his mind was ever on the future.

We feel, therefore, in closing this hundredth volume, we cannot do better than print a portrait of our late founder and friend, together with the following quotation from the article he wrote to mark the opening of our fiftieth anniversary on January 1st, 1948, the last article in which he expressed his views upon the future of model engineering :—

"I have no hesitation in saying that the future of model engineering is fully assured. There will always be natural craftsmen who love doing good work for its own sake, there will always be enthusiasts who love to explore and revive in miniature the engineering triumphs of the past, there will always be experimentalists who will delight in investigating the realms of scientific discovery and in their own workshops contributing to its progress. All these good folk THE MODEL ENGINEER will continue to serve with unabated energy, it will always offer them a platform for a record of their work, and for the dissemination of that mutual goodwill which is the hall-mark of the true model engineer... May the next half-century be marked by a parallel record of progress, and if I may say so in all modesty, by a corresponding rendering of faithful service to all who may be included in our constantly expanding circle of happy and friendly readers."

That was typical of the thoughts of "P.M.", and it is constantly in the minds of those of us who succeed him.

(Photograph overleaf by W. J. Bassett-Lowke.)



Traction Engine Prototypes

A New Blue-Print Service

by W. J. Hughes

THE average model engineer who wishes to build a model traction engine is often very limited in his choice, because particulars of these grand machines are few and far between. At one time he could have found within a few miles of his own home probably half-a-dozen different prototypes; now he is lucky if there is one within twenty or thirty miles' radius.

Again, many makers have gone out of business; and others still in existence who would be willing to help are unable to do so either because they now have no personnel of traction engine days, or because the salvage drive claimed old catalogues, drawings, and other materials which could have given the required information.

It is my firm belief that if more information had been available in the past, there would have been more model traction engines built. For here is an engine which can haul live passengers without any special track—in the back-yard or on the garden path—whereas the small loco needs either an expensive track of one's

own (if one has room for it) or needs carting about to the club track (if the club has one). Apart from this, the traction engine can be run (indoors or at exhibitions) as a stationary engine, whereas a small loco looks just silly working with its wheels jacked up!

Again, by choice of a suitable prototype, one can build a traction engine of a simple nature—the unsprung single-cylinder general purpose engine—or in a much more complex form as the lordly compound road locomotive, on springs and with three speeds: perhaps with showman's fittings, too.

The New Service

It is with these thoughts in mind that I have drawn out several traction engines, and believe that these will fill a long-felt need.

The drawings have all been made either directly from or with assistance from official makers' drawings or from other authentic sources, or alternatively from measuring up an

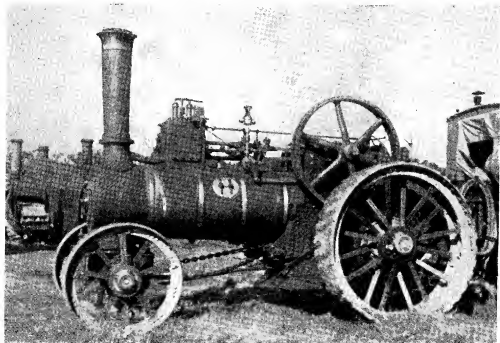


Photo by courtesy]

[J. Robertson

Fig. 1. The Marshall general-purpose traction engine. Unsprung and with single cylinder, this is the simplest of the prototypes. The slightly curved flywheel and rectangular "spud"-pan are typical of the Marshall

actual engine, and they can, therefore, be relied on as accurately representing the prototype. All the engines are drawn to 1½-in. scale, which gives a robust engine capable of hard work, and of being machined on the average 3½-in. centre-lathe. They are of varying types and makes, and it is hoped to add further to the list as opportunity (and spare time) allows.

The following brief description of each prototype will be expanded in much greater

Overall breadth	7 ft. 1 7/8 in.
Wheelbase	9 ft. 8 in.
Height to top of chimney ..	10 ft. 7 1/2 in.
Diameter and breadth of hind wheel	6 ft. × 1 ft. 6 in.
Diameter and breadth of front wheel	3 ft. 9 in. × 9 in.
Diameter and breadth of fly-wheel	4 ft. 3 in. × 6 in.

By the way, some readers may take exception



Photo by courtesy

(John G. Earnshaw)

Fig. 2. Allchin No. 3257 "Royal Chester" as she appeared when new in 1925. This engine is slightly more complex than the Marshall, being sprung on both axles. After a quarter of a century she can still tick over like a sewing machine

detail in subsequent articles, with the Editor's permission.

The Marshall 7 N.H.P. General Purpose Engine

Used chiefly for general purpose agricultural work, such as threshing, many thousands of these engines were built. This is the simplest of the prototypes, with a single cylinder, two speeds, and not sprung on either axle.

The engine is of the four-shaft type, with change-speed gearing between the hornplates, operated by a single lever, so that it is not possible to engage both gears at the same time.

The cylinder of the prototype is 8½-in. bore, with a stroke of 12 in., and the cross-head works in a bored trunk guide. A differential gear is fitted to the hind axle on the right-hand side, and a brake drum and winding drum on the left-hand side.

Principal dimensions of the prototype are:

Overall length 17 ft.

to my statement that the machining of a 1½-in. scale model may be carried out on a 3½-in. lathe, having regard to the fact that in this scale the hind wheel works out to 9-in. diameter × 2½-in. wide. However, this can be done if the wheel is built with two separate tee rings, as in the prototype. These will be only 1½-in. wide, and can then be machined in the gap of the lathe. Actually, this may be easier than turning the rim in one piece, because in the latter case a special tool must be made to turn the recess between the two vertical webs of the rim.

These drawings were made from my own measurements of a Marshall 7 h.p. engine, with confirmation and additional detail from official drawings supplied by the builders, Messrs. Marshall, Sons & Co., of Gainsborough, to whom we are extremely grateful.

The Allchin 7 N.H.P. General Purpose Traction Engine on Springs

This engine is rather more complex than the

Marshall, being fitted with springs on both axles. Those on the hind axle allow only about $\frac{1}{2}$ in. of movement, and could be left out if desired, but that on the front axle is a prominent feature, of course, and so should be fitted.

The bore and stroke are the same as those of the Marshall (and indeed common to all 7 n.h.p. engines), and the engine is of the 4-shaft type with similar change-speed arrangements to the Marshall. However, the final drive from third shaft to hind axle is on the left-

build a Showman's Engine, this drawing will be very useful, for the prototype was a great favourite among showmen in all parts of the country. It is hoped later to add a second sheet of drawings, to include details of the necessary fittings to convert this to a showman's engine, by the way.

My drawings are made from the official builder's drawings, and for permission to do this I am greatly indebted to Messrs. J. H. McLaren, of Leeds, who took over Fowlers' steam engine business about ten years ago.

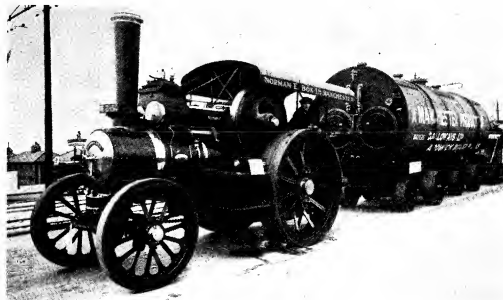


Photo by courtesy]

[Norman E. Box
Fig. 3. The Fowler "Big Lion" road locomotive No. 16263 "Talisman," after winning first prize in the Manchester Civic Parade of 1925. And no wonder, for what petrol-driven vehicle could match the dignity and majesty of this venerable King of the Road? (N.B. As a matter of interest, the small notice-board on the boiler bogie reads "Stop Me and Buy One"!)]

hand side, incorporating the differential gear, of course. The winding drum is on this side, too, but the brake works on a drum on the third shaft, behind the second motion spur-wheel.

There are two sheets to the Allchin drawings, which were made entirely from my own measurements of Allchin No. 3251, at a yard in Gleadless, Sheffield.

Principal Dimensions:—

Overall length	17 ft.
Overall breadth	7 ft. 5½ in.
Wheelbase	9 ft. 8 in.
Height to top of chimney	10 ft. 9½ in.
Diameter and breadth of front wheel	3 ft. 8 in. × 9 in.
Diameter and breadth of fly-wheel	4 ft. 6 in. × 5½ in.

The Fowler "Big Lion" Road Locomotive, on Springs

The big road locomotive is the admiration of all, and the Fowler B.6 is a most worthy representative of this class. To anyone wishing to

The "Big Lion" was of 8 n.h.p. (bore and stroke 6½ and 11½ in. by 12 in.); the cylinders were compound, of course, with the valves overhead. There were three speeds, operated by levers fitted with an interlocking device so that not more than one gear could be engaged at one time. As on all road locomotives, both axles were sprung, and the Fowler hind axle was allowed up to 2 in. vertical movement. To effect this, it was coupled by links to the third shaft, which meant that both rose and fell together, and the drive from second to third shaft was through an ingenious universal coupling, which I shall describe in a later article, together with the compensating levers which prevented rolling and swaying on uneven ground.

Principal Dimensions:—

Overall length	19 ft. 9 in.
Overall breadth	7 ft. 11½ in.
Wheelbase	10 ft. 3½ in.
Height to top of chimney	12 ft. 7½ in.
Diameter and breadth of hind wheel	7 ft. × 1 ft. 6 in.

Diameter and breadth of front wheel	4 ft. 7½ in. × 9 in.
Diameter and breadth of fly-wheel	4 ft. 6 in. × 6 in.

The Farmer's Engine of 1849

A century ago, a traction engine was built in Yorkshire which was highly successful for its time and day. The two high-pressure cylinders were under the smokebox, driving a counter-shaft in front of the firebox, and on the counter-shaft were gears by which the hind axle could be driven at either of two speeds. In general appearance and performance a model of this engine would be a worthy companion to "L.B.S.C.'s," "Rainhill," but with the advantage that no track would be required.

I first came across the engine in the book *English and American Steam Cars and Traction Engines*, by W. Fletcher, published by Longman's Green over half a century ago, and since the book is long out of print, Messrs. Longman's have kindly given permission for the reproduction of the drawings and of the descriptive material, also to be published in a later article.

Principal Dimensions :—

Overall length	10 ft. 10 in.
Overall breadth	5 ft. 2 in.
Wheelbase	5 ft. 9 in.
Height to top of chimney	9 ft. 3 in.
Diameter and breadth of hind wheel	4 ft. × 5½ in.
Diameter and breadth of front wheel	2 ft. 8 in. × 5½ in.

There was no flywheel, by the way; the hind wheels were blocked up clear of the floor when it was required to drive a threshing machine or other equipment.

The Aveling and Porter Compound Steam Roller

Model steam rollers are even more scarce than traction engines, and it is hoped that the publication of this drawing may help to remedy the deficiency.

This particular engine is of the piston-valve type, and since our mutual friend "L.B.S.C." has given full particulars of machining procedure for piston-valve cylinders, these should present no difficulty to the would-be modeller.

In other ways a steam roller presents less difficulty than a traction engine; for example, there is no differential to fit, and, of course, no

strakes on the "wheels." But it has to be admitted that the machining of the hind rolls presents a certain amount of difficulty on a 3½-in. lathe, though the dilemma is not insuperable, as I hope to show in my expanded article on this engine.

Principal Dimensions :—

Overall length	18 ft. 8 in.
Overall breadth	6 ft. 5 in.
Wheelbase	10 ft. 11 in.
Height to top of chimney	11 ft.
Diameter and breadth of hind roll	5 ft. 6 in. × 1 ft. 4 in.
Diameter and breadth of front rolls (2)	4 ft. × 4 ft.
Diameter and breadth of fly-wheel	4 ft. × 5 in.

My drawings are made from official Aveling & Porter drawings kindly lent to me by Mr. A. R. Dibben, of Timperley, Cheshire, and I am also grateful to Messrs. Aveling-Barford Limited of Grantham, for permission to copy them for this new service.

Traction Engine Drawings

Obtainable from Percival Marshall & Co. Ltd. post free.

Drawing No.	Description	Price
T.E. 2. (Sheets 1 & 2)	Allchin 7 n.h.p. General Purpose Traction Engine (on springs). Single Cylinder.	7/6
T.E. 3.	Farmer's Engine of 1849. (Undertype). Double Cylinders.	2/9
T.E. 4.	Marshall 7 n.h.p. General Purpose Traction Engine (unsprung). Single Cylinder.	4/6
T.E. 5.	Fowler "Big Lion" 8 n.h.p. Road Locomotive (on springs). Compound Cylinders.	4/6
T.E. 6.	Aveling & Porter Type F 10-ton Road Roller. Compound Cylinders: Piston Valves.	2/9

Our Cover Picture

MANY of our readers know the thrill of testing out a model under power for the first time, and when this test is the culmination of many months, or sometimes years, of patient effort, it is an event of more than ordinary importance. Model locomotive construction, in particular, calls for long and careful work on the many details all vital to its eventual success, and the satisfaction of seeing it run success-

fully is eagerly looked forward to by the constructor.

The model shown in the photograph is a 3½-in. gauge "Hi-Lan" Lassic constructed by Mr. F. Dickinson, of the Sutton Model Engineering Society, with the aid of Mr. J. Dickinson Junr., who is seen here raising steam in preparation for test on the club's continuous track which, it may be added, proved entirely successful.

Ambition Realised!

by
"L.B.S.C."

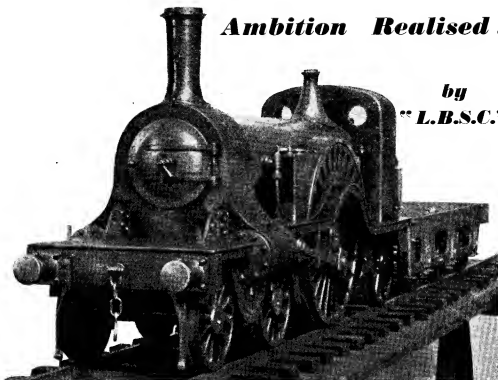


Photo by]

"A little bit of old Doncaster"

[J. E. Murray

JUST over half-a-century ago, a little boy nine years old, reading a copy of a journal called *Work*—something that very few modern boys of that age would do!—found in it the start of a series of articles on how to build a "one-inch-scale" Great Northern eight-foot Stirling single-wheeler. Being well and truly infected with what Michael Reynolds used to call "locomotive measles," the boy naturally longed to get busy and build the engine; but alas! due to lack of the necessary equipment, for one reason alone, it was completely out of the question. He therefore did the next best thing, copied out all the drawings to full size, and very nearly learned all the instructions by heart, for some day he was determined to carry out his ambition.

Time rolled on, as it has a habit of doing (don't I know it!) and some forty years elapsed. Then one day, the middle-aged man who was once the little boy, was reading a copy of this journal. In it was an article describing a marine engine, and it stated that the castings were supplied by W. Martin & Co. of East Ham. The name seemed familiar, and suddenly a chord of memory was struck; it was the firm who were supplying castings for the single-wheeler described in the old journal. The ambition to build her was rekindled; our friend, whose identity is Mr. Tom Horne, of Hawick, Roxburghshire, in the Land of Cakes

and Haggis, at once got into communication with Waller Martin, who had just restarted advertising after a lapse of many years. To the great delight of Mr. Horne, Martin was able to supply wheel and cylinder castings, and some of the other parts specified for the original job, and so, at long last, our friend started in to keep his boyhood vow. That was ten years ago; the pictures reproduced here, show the progress that has been made, up to the present time.

Not as Originally Designed!

Mr. Horne had meanwhile become acquainted with these notes, previous to making a start on the job, and realised that my specifications for a successful locomotive didn't exactly agree with those set out in the old journal; so he decided to adapt "L.B.S.C." principles to the building of the engine, and did so, with gratifying results. The engine is built to 5-in. gauge, with frames, axleboxes, etc. of the usual pattern, and has coil springs to every axlebox, including the tender; she has the old original type of oak buffer-beam. The frames are well supported by a stay incorporating the valve spindle guides and twin feed pumps, all in one gunmetal casting. The wheels are Martin's "inch-scale" standard size; the driving-wheel balance weights can be seen through the slots in the splashers, in the broadside view of the engine.

The cylinders are of cast-iron, and are of 1-1/2-in.

bore by 2½-in. stroke, with ordinary slide-valves actuated by Stephenson link-motion, having launch-type links. Lubrication is attended to by a mechanical lubricator located on the footplate. This is driven by an eccentric on the trailing axle, and delivers oil via two check-valves, through a hollow stay, to the main steam pipe at the smokebox end. Mr. Horne wanted to have the outside appearance just right, with

fluo." The boiler steams very well, and although Mr. Horne only has 90 ft. of straight line, the engine has made a good show on it, getting away with four adults by aid of her working sand gear. This is operated by the handle and cross-rod shown in the footplate view. It may not seem much for a 5-in. gauge engine, but it must be remembered that she is only a very small type, in fact the total weight is only approximately

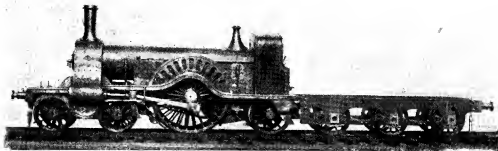


Photo by

An old-timer coming to life

[J. E. Murray

details such as connecting-rod big-ends, and so on, looking like those on the big engines. He had some difficulty in getting authentic drawings; but the excellent illustrations accompanying the article on the full-sized engines by Mr. F. C. Hambleton ("Bro. Tail Lamp!") solved this problem, and caused alteration of some of the already-made parts, notably the cab and chimney. Incidentally, a kind personal friend presented me with a copy of the book containing a selection of that worthy magician-of-the-pencil's outline drawings of the old-timers, with appropriate notes; it brought back old memories, and I most heartily recommend its purchase by all lovers of old-time locomotives, whether they build engines or not—even though it includes the heart-and-back-breaking "Vulcans" of the L.B. & S.C.R.R.! I'm afraid I skipped that page. Hint to Mr. J. N. Maskelyne—what about a companion volume?

Pat Stirling—Up to date

The boiler follows your humble servant's usual specifications, though externally it is "to scale." The barrel is 4-in. diameter, and contains twelve ⅜-in. copper tubes and one ⅜-in. flue; it was built before I started to advocate a much higher superheat. Although the steam temperature is just moderate, it is a great improvement on wet steam. The firebox is 5½ in. deep, the grate measuring 5 in. by 2½ in., and around the walls are over seventy 2-B.A. copper stays screwed in and riveted over. The crown-stays are my usual type of plate girders.

The barrel and wrapper are in one piece, the barrel tube being split and opened out, the requisite depth of firebox being obtained by riveting on extension pieces. All the joints are flanged and snap-riveted. The whole lot, including tubes, was silver-soldered with "Easy-

65 lb., and much of this is on the bogie, owing to the distance between the cylinders and the driving axle. To even things out a little, our friend proposes to follow full-size practice, and put a drag weight under the footplate.

The boiler is set a shade higher than "scale," to clear the launch links in back gear. The fittings and mountings are as usual, as can be seen from the illustrations; in addition to the pumps there is an injector set vertically, delivering into a clack on the side of the firebox wrapper. Those conversant with locomotive history, may recall that Pat Stirling tried clacks low down on the firebox wrapper, but later altered them to the usual position. There is also some doubt about the type of regulator fitted. Mr. Horne says that he understood that originally, old No. 1 had a quadrant regulator, with the valve in the smokebox, so he fitted a similar arrangement, using a steam-collecting tube in the barrel, with a lot of fine sawcuts in it, and one of my disc-in-a-tube regulator valves at the end. This has two main ports and a pilot port. The only drawing I ever saw of old No. 1's footplate, showed a pull-out regulator, so if she did actually start life with a quadrant, it must have subsequently been removed. The original boilers had spring-balance safety valves under the brass casing, but these were replaced by Ramsbottom valves. The turret is set vertically over the backhead, as there is not much of the wrapper projecting into the cab, and the whistle valve is set on top of it to clear the regulator handle.

The boiler looks ridiculously small for a 5-in. gauge engine, and yet it does the job, same as its full-size relations. The late Sir H. N. Gresley remarked on more than one occasion, that it was a marvel what the engines did with no boiler worth writing home about, in a manner of speaking; and though a great engineer and

a clever designer, he wasn't above taking a few "ints and tipses" from his illustrious predecessor's work—which proved that he *was* a great engineer. Those whose knowledge is great, are ever anxious to learn more; there are others—"nuff sed!"

It is easy to imagine the satisfaction that friend Horne must feel, at the fulfilment of his ambition, after the passing of half-a-century; but he hasn't been idle, as far as locomotive work is concerned, all that time. Before starting to follow my notes, he built a 4-6-0 mixed traffic engine, similar in appearance and dimensions to those on the old Great Central Railway; and "according to ancient custom," only put in four 1-in. tubes in the boiler barrel. Naturally, the boiler was a poor steamer; and later, after discovering the "Live Steam" notes, Mr. Horne wrote to me about it, and I told him what to do. He made a new boiler with a combustion chamber, twenty-four $\frac{1}{2}$ -in. tubes, and a couple of $\frac{1}{2}$ -in. superheater flues, and said it was an absolute and complete revelation. Soon after the new boiler was fitted, the engine hauled over four thousand passengers at the Worker's Trades and Crafts Exhibition in Waverley Market, Edinburgh, earning about £25 for the Royal Infirmary. She was operated by some of the "full-size" drivers from the local sheds, who came along when they could spare the time; and the engine gave no trouble whatever.

Mr. Horne says he hopes to finish off the Stirling single-wheeler in the not-too-distant future, and may be able to put it on show at next year's "M.E. Exhibition." I hope he does, for it will be a welcome sight to all who love the old-timers, and a reminder of the days when engines really looked like engines, instead of resembling a spam can on wheels!

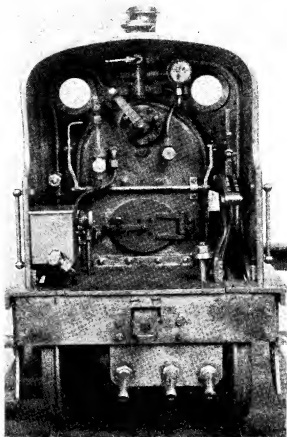


Photo by]

[J. E. Murray
Utility takes preference here!

Beginners' Corner

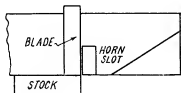
My recent note about restarting a "beginners' corner" has been welcomed by the newer and younger members of our fraternity, and many suggestions have come to hand as to how it should be worked. Three or four of our older readers reckon it is a waste of time and space, saying that anybody who isn't an absolute Billy Muggins of the first water, should be able to follow my ordinary instruction, quoting some fine "first attempts" as evidence. Quite so; but nature doesn't make all persons alike—scientists go so far as to say there are no two alike, which is just as well, for another one like your humble servant would "exceed the limit"—and whilst some folk can, for example, read a drawing at a glance, others need a little explanation. Taking

another viewpoint, I know a "raw recruit" to locomotive building, who had the wherewithal to equip a really complete workshop, and knew quite a bit about motor engineering; contrarilywise, as Mary Ann would remark, I know another who is a butcher's assistant. He rigged up a small garden shed for a workshop, with a "baby" lathe of 1 $\frac{1}{2}$ -in. centres, a bench with a vice, and few tools. He didn't know how the piston was pushed up and down the cylinder, but he was eager to learn. Incidentally, in view of the present state of the meat ration, he has plenty of time available! So you see there are beginners, and beginners!

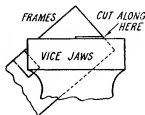
However, I won't waste more space dilating on readers' suggestions, but just sum up. The general call is for a detailed description of a simple and inexpensive type of engine, that an absolute tyro can build, starting from zero with no previous experience or knowledge whatever, and yet be confident of success. Two stipulations are, minimum of outlay for castings and

How to Mark Out the Frames

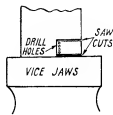
Now, brother tyros, this is how you mark out your frames, as easy a job as ever was. Test one long edge of the plate against a steel rule, and see that it is dead straight; if it isn't, file away the high spots. Then put your try-square against the end, stock to top of frame plate, and blade to the edge, as near as you can get it. Scribe a line down, using blade as guide. Along the top edge, starting from the scribed line, make a



How to mark out hornblock openings



Easy way of sawing straight



How to cut out hornblock openings

mark $4\frac{1}{8}$ in. away, another mark $4\frac{1}{8}$ in. beyond that, and finally another $4\frac{1}{8}$ in. beyond the last one, which will come pretty close to the edge of the plate, as the overall length of the finished frame is $12\frac{1}{2}$ in. Now, with the stock of your square resting on top of frame, set the blade to all the marks, and scribe a line clean across the plate, at each mark. You'll have to reverse the direction of the stock of the try-square to do the last one.

Now test if the bottom edge of the plate is parallel with the top edge; if all four scribed lines are exactly the same length, it is O.K. These lines should be $2\frac{1}{8}$ in. long, if the width of the material is correct. If not, mark off a point $2\frac{1}{8}$ in. from the top, on first and last lines; join them, and cut or file the metal away to the line. At bottom of frame plate, mark off a point $\frac{1}{8}$ in. each side of the two centre-lines. Using your square with the stock against the bottom edge of frame, draw a line $1\frac{1}{8}$ in. high at each point; then connect the tops with another straight line across each pair. That gives you the correct location of the openings for the hornblocks.

At $\frac{1}{8}$ in. from the bottom of the third vertical line, make a mark, and centre-pop it. That is the running position of the driving-axle. On the first line, at the front edge of frame, mark a point of $1\frac{1}{32}$ in. from the top. Draw a line from that point, to the centre-dot just made; that gives you the centre-line of motion, from which the location of the cylinders has to be set out. On this line, at $1\frac{1}{8}$ in. and $1\frac{1}{8}$ in. respectively, scribe two lines at right-angles to the inclined one, putting the stock of the square exactly level with the inclined line. Mark off a point on each one, $\frac{1}{8}$ in. below the inclined line, and join them. Mark off two similar points $1\frac{1}{8}$ in. above the inclined line, and join them also. The enclosed space gives you the exact location of the cylinder bolting face. Scribe a line exactly down the centre of this, that is, $\frac{1}{8}$ in. from each side; easily done if you

keep the stock of the square set to the long inclined line. That gives you the vertical centre-line of the cylinders.

Now for the cylinder stud holes, and the holes for steam and exhaust pipes. At $\frac{1}{8}$ in. below the inclined line (centre-line of motion), also at $\frac{1}{8}$ in. above it, draw two lines parallel with it. Make centre-pops at the points where these lines cross the vertical centre-line. The upper one indicates the hole for the exhaust pipe; the

lower one is the middle stud hole of the bottom row. At $\frac{1}{8}$ in. on either side of these pops, make four more, and there are your stud holes. Next, at $\frac{1}{8}$ in. above the upper row, and $\frac{1}{8}$ in. ahead of the vertical centre-line of the cylinders make another pop mark, and that settles the position of the hole for the steam pipe.

Next, we want the shape of the frame. On the vertical line nearest to the left-hand side of the plate, set out a point $\frac{1}{8}$ in. from the top, and draw a line from it, straight to the left bottom corner of the rectangle indicating the cylinder bolting face. Then, on bottom line of frame, mark off a point $\frac{1}{8}$ in. ahead of the centre-line of the front hornblock opening, and draw a line from that, also to the front corner of the cylinder location. On the bottom of the frame, $1\frac{1}{8}$ in. behind the centre-line of the rear hornblock opening, mark a point, and draw a line from this, to a point $\frac{1}{8}$ in. below the top line of frame, on the vertical line at the back end, and there is your frame outline. Simple enough, sure-ly, as they say down in Sussex.

Next item, screw-holes for pump stay. At $1\frac{1}{8}$ in. behind the centre-line of front hornblock opening, scribe a vertical line, with your try-square stock held against bottom of frame; and on it set out and make three centre-pops, $\frac{1}{8}$ in., $\frac{1}{8}$ in. and $\frac{1}{8}$ in. again, measuring from bottom of frame. At $\frac{1}{8}$ in. from each end of top of frame, scribe a short vertical line, and another $\frac{1}{8}$ in. from that. On the ones nearest the end, make centre-pops $\frac{1}{8}$ in. from top, and $\frac{1}{8}$ in. below that. On the other one, make a centre-pop half-way between the two first marked; and that completes your marking out. You can do it as quickly as I can write the instructions!

How to Cut Out the Frames

If you own, or have the use of a bench shear, all you have to do is to cut the outline with five snips of the shear along the two ends and the three diagonal lines. If not, drill the three

(Continued on page 801)

IN THE WORKSHOP

by "Duplex"

*40—Gear-cutting in the Lathe

THE making of the eccentric body or sheave (1) has already been described, and it now remains to give details of the construction of the eccentric strap, together with the other parts forming the rocking gear attached to the arbor. To bring to mind the arrangement of the various parts, reference should be made to the photographs and drawings given in the previous article.

for facing the back surface with the work mounted on a stub mandrel.

To mark-out the position of the threaded hole, into which the eccentric-rod fits, the previously scribed cross centre-line is continued across the width of the strap with the aid of a square ; the centre of this line is determined with the jenny callipers then is punch-marked and centre-drilled.

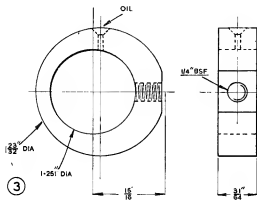


Fig. 13. The eccentric strap

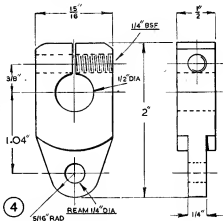


Fig. 14. The arbor rocking arm

The Eccentric Strap, Part 3, Fig. 13

To ensure good wearing qualities, either cast-iron or bronze is used for making the strap. A short length of suitable material of $1\frac{1}{2}$ in. outside diameter is gripped to run truly in the four-jaw chuck, and is finish-turned on the outer diameter and then faced. The lathe tool is then fed across the face of the work to scribe the centre-line; this line should be cut rather deeply so that it is not obliterated when the second facing cut is taken at a later stage.

Remove the work from the chuck and with the jenny calipers set to $\frac{1}{4}$ in., scribe a mark crossing the centre-line; centre-punch the intersection of these two lines and drill with a centre drill. The work is now replaced in the four-jaw chuck, and with the aid of the wobbler the centre hole is set to run truly. After the bore to receive the eccentric sheave has been machined to provide a good working fit, the end of the bar is trued by taking a light facing cut, and the strap is parted off a little in excess of its finished width to allow

The next step is to set the strap on edge in the four-jaw chuck with the cross centre-line of the bore lying horizontally and at centre height; at the same time, the centre-drilled hole for the rod is set with the wobbler to run truly.

The centre hole is then drilled with a No. 4 drill and tapped $\frac{1}{4}$ -in. B.S.F., and the abutment face for the nut fitted to the rod is formed with a facing tool, as represented in the drawing.

To complete the machining, an oil well is drilled on the upper surface of the strap or, if preferred, a cycle-type lubricator can be fitted, as shown in the photographs of the part.

The Arbor Arm. Part 4. Fig. 14

Mild steel is used to make this part and, although the machining is quite straightforward, it is essential that the $\frac{1}{2}$ -in. diameter bore should be a close fit on the end of the arbor, in order to ensure that when the cross-bolt is tightened the part is securely clamped in place.

The narrow tongue, on which the fork of the operating-rod fits, can be readily machined by clamping the part to a stub mandrel gripped in the chuck, and then removing the surplus metal

*Continued from page 746, "M.E.," June 16, 1949.

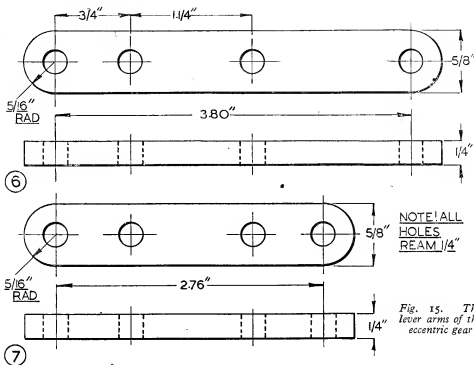


Fig. 15. The lever arms of the eccentric gear

by a turning operation. The pivot hole should be finished with a reamer and, if the appliance is to be subjected to much use, it may be found advisable to case-harden the part as a whole.

The Linkage Levers. Parts 6 and 7. Fig. 15

These parts are also made of mild steel and may, if desired, be case-hardened to resist wear at the pivot holes.

The dimensions given are applicable to a lathe of 4 in. centre height, and for lathes of other sizes it is essential to maintain the exact relationships shown in the drawings, in order to impart the correct angular motion to the arbor when machining the gear cutters.

The Distance-pieces and Cross-bolts.

Parts 8. Fig. 16

In conformity with the other parts comprising the eccentric mechanism, these fittings should be made of mild steel.

The machining is carried out in accordance with everyday practice and calls for no special comment.

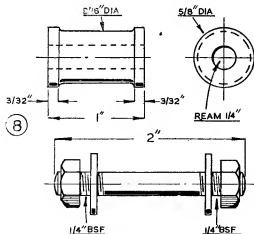


Fig. 16. The distance collars and bolts

The Pivot Pins. Fig. 17

These should be accurately fitted and preferably case-hardened to resist wear. The ends of the pins are grooved to take small cir-clips made of spring steel wire. These clips can be readily made by cutting off a single coil of a compression spring of suitable diameter, and then twisting the rings flat with the pliers. In the case of the pivot pin fitted to the arbor arm, one end carries a special clip of the form shown in the drawing; this is to enable this one pin to be readily withdrawn and so provide for the quick removal of the attachment from the lathe.

The Link Forks. Part 10. Fig. 18

These are made from 1/2-in. square-section mild-steel bar, and the slots are machined with a circular milling-cutter while the material is

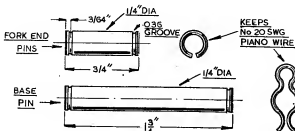


Fig. 17. The pivot pins and securing clips

secured in the lathe toolpost. The pivot holes and the threaded bores to receive the link-rods are marked-out and then drilled either in the lathe or the drilling machine. It is again advisable to case-harden these parts.

The Link Rods. Parts 11 and 12. Fig. 19

Mild-steel of $\frac{5}{16}$ in. diameter is used to make these parts, and it is essential that, when they are assembled, the eccentric and the arbor arm should take up the positions represented in Fig. 9, in order that the arbor itself is correctly operated in accordance with the design.

The Link Anchor Plate. Part 9. Fig. 20

Although the drawing shows this part as made for use with a 4-in. lathe, it may be found necessary to vary the details of its construction to suit the bed shears of any particular lathe.

The plate is located by means of a tenon secured in place by screws inserted from the under side.

The clamping plate and bolt of the design shown can be used where the bed shears are undercut, but, where this is not the case, it may be found necessary to make use of the angular guide-ways and fit clamping bolts of the type employed to secure the fixed steady to this form of lathe bed.

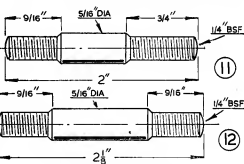


Fig. 19. The link-rods

order not to break the sequence of these machining operations.

The Cutter Drilling Jig. Figs. 21 and 22

The gear cutters, which are described in detail at a later stage, have an outside diameter of $1\frac{1}{2}$ in. and carry twelve teeth.

To enable these teeth to be accurately spaced, a series of twelve equally-spaced holes is drilled in the cutter blank by means of a jig of the form illustrated in Fig. 21, which shows the several parts of the device and a partly machined cutter blank in position.

The jig consists of a base or drilling block (A), a drilled jig plate (B), and a central clamping-bolt (C), as denoted in both the photograph and in the working drawings in Fig. 22.

The nut for the clamping-bolt is that already made to screw on to the arbor of the relieving attachment.

The base block is formed from a piece of $1\frac{1}{2}$ -in. diameter round mild-steel bar which is gripped in the chuck and faced, and then bored $\frac{1}{2}$ in. diameter. The clearance groove to receive the point of the drill when the cutter blank is being drilled, is best machined with a square-face boring tool akin to that used for cutting internal square threads.

Next, the base-piece is parted off and, after

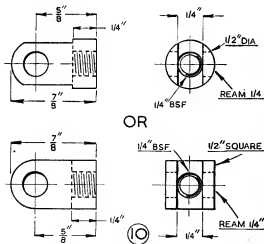


Fig. 18. The link-rod fork ends

it has been reset in the chuck to run truly, the under surface is faced and the recess to accommodate the head of the clamp-bolt is machined with a boring tool.

The jig plate is made from a similar piece of material, and, when it has been faced, the bore is machined or bored and reamed to an exact fit on the arbor of the relieving attachment, that is to say, the end portion of the arbor designed to carry the cutter blank.

The twelve holes are drilled at this setting on a pitch circle $1\frac{1}{16}$ in. in diameter.

This drilling operation is carried out by indexing the lathe mandrel to twelve divisions, either with a headstock dividing attachment or by means of a change wheel secured to the lathe mandrel. To machine the holes, a short, stiff Slocomb drill is first entered, and this is followed by a $\frac{1}{8}$ -in. diameter stub drill having a total length of about 1 in. These drills are either mounted in a drilling spindle attached to the lathe saddle, or the drilling attachment for the back toolpost, previously described, will serve this purpose well. The drill, mounted at centre height, is first set to the lathe centre-line and is then moved exactly 0.531 in. away from the centre-line, as determined by the cross slide index. The mouths of the holes should be lightly countersunk, either by means of the Slocomb drill in the first instance, or as a separate operation subsequent to drilling the holes.

Next, the jig plate is parted off to length, and if the under surface requires to be faced, the plate is mounted on a shouldered stub mandrel to ensure true running. Finally, the jig plate is case-hardened to enable it to withstand continued use.

The clamp-bolt is turned to an exact sliding fit in the bore of the jig plate, and the head portion

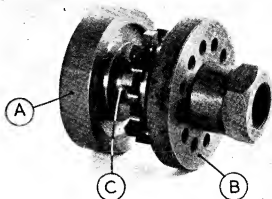


Fig. 21. The cutter drilling jig

should be made a firm press fit in the counterbore of the base to prevent the bolt turning when the nut is tightened; if the parts have been properly fitted in this way, there should be no need to fit a snug or pin to the bolt-head for this purpose. Before the bolt is parted off to length, it is threaded for the clamp-nut either with the aid of the railstock die-holder or, preferably, by employing a screw cutting operation.

The Sawing Jig. Figs. 23 and 24

As will be described in detail later, the teeth of the cutter are cut out by feeding the blank radially against a circular metal slitting saw mounted between the lathe centres; and for this operation the cutter blank must again be correctly indexed to conform with the series of holes already drilled with the aid of the drilling jig. For this purpose, the jig illustrated in Fig. 23 is used, and it will be apparent that the index pin fitted to the shank of the tool will ensure that the teeth are correctly spaced.

The dimensions of the component parts of the jig are shown in the working drawings, Fig. 24. The material used to make the shank should be quite flat, in order to give a firm seating for the cutter and also to prevent the tool rocking when clamped in the lathe toolpost.

The clamping-bolt is turned to the correct diameter by using the drilling plate of the drilling jig as a gauge, and, as before, it is threaded to take the clamp-nut belonging to the arbor of the relieving attachment. The shank is bored to afford a firm press fit for the clamp-bolt, and, to ensure this, it may be found best to clamp

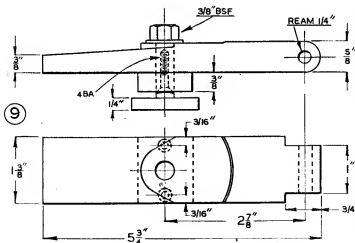
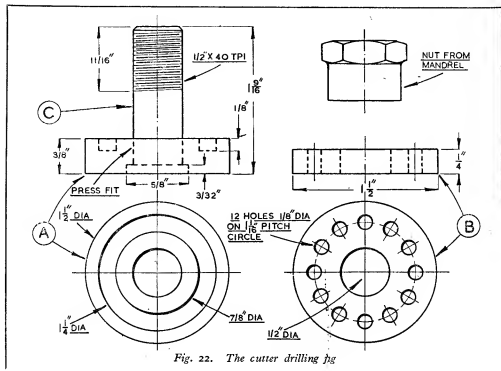


Fig. 20. The anchor block fitted to the lathe bed



the shank to the lathe faceplate and bore it in this position.

When the clamp-bolt has been fitted, the centre-line is marked-out on the shank, and the drilling plate of the drilling jig is clamped in place so that one of its holes is centred on this line. An $\frac{1}{8}$ -in. diameter drill is then entered in this hole and fed in for a short distance; this is followed by a No. 31 drill put right through the tool shank. The mouth of this hole may be opened out with an $\frac{1}{4}$ -in. reamer, to afford a start for the $\frac{1}{2}$ -in. diameter

silver-steel register pin which is then pressed firmly into place in the vice.

At this stage, the arbor of the relieving attachment may be completed by having its register pin fitted. This is done, in the manner just described, by clamping the drilling jig plate to the end of the arbor so that one hole lies with its diameter in line with the line previously scribed on the arbor web.

This procedure enables the hole to receive the arbor register pin to be accurately located and drilled, as in the previous instance.

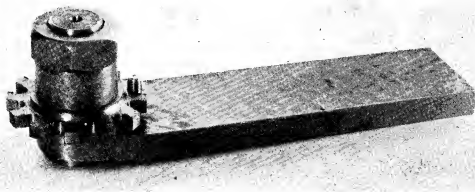


Fig. 23. The sawing jig for forming the cutter teeth

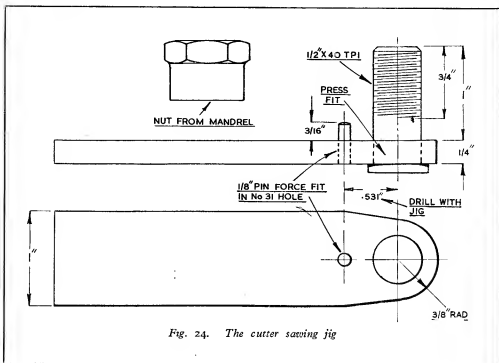


Fig. 24. The cutter sawing jig

If up to now the work has been properly carried out, it will be clear that the use of the hardened drilling plate of the drilling jig as a gauge will have enabled the cutter mountings to be machined to exactly the same diameter;

moreover, the register pins fitted to the arbor, to the drilling jig, and to the sawing jig will be located at precisely the same centre distance.

(To be continued)

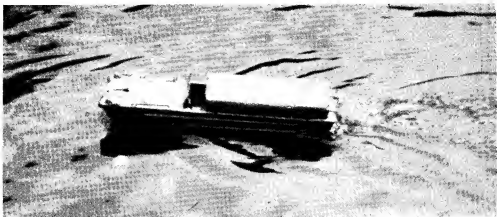
"L.B.S.C."

(Continued from page 795)

No. 40 holes, already marked out, at each end of the frame plate. Temporarily clamp the plates together, and make certain they line up all ways; then drill one hole at each end of the lower plate, using one of the already-drilled holes in the upper one as a guide, and temporarily rivet them together with a couple of 3/32-in. rivets. Drill all the holes through both plates at once, with No. 40 drill; then open out the larger ones with the drill sizes specified on the drawing.

To cut the frames to outline, when a shear isn't available, just catch the frames in the bench vice with the marked line showing level with the vice jaws. Put a fine-toothed hacksaw blade, say about 22 teeth per inch, sideways in the saw frame, and saw along the marked line with the

side of the blade resting on top of the vice jaws, which thus guide the cut straight. A drop of cutting oil, as used for lathe turning, helps the saw to walk through the steel. Next, put the frames vertically in the vice, with the line marking side of hornblock slot showing at the jaws, and saw as far as the cross line. Drill a few holes just under the cross line, and break out the piece by grabbing it with a pair of pliers, and bending back and forth like a National Health Service dentist doing a bit of overtime. Finally, smooth out all the saw-marks with a file; knock out the temporary rivets, and there are your finished frame plates. The whole job shouldn't take more than one evening. Next stage, hornblocks, buffer-beams, and frame erection.



The model DUKW seen in action

THE VICTORIA REGATTA

THE Victoria M.S.C.'s annual regatta, held on Sunday, 22nd May, turned out to be a very enjoyable day's sport, although the circular-course craft had a very lean time. The interest, however, was well maintained by numerous steering and prototype craft.

This regatta marked the first competition appearance of two clubs who have recently affiliated to the M.P.B.A., namely, Bedford, and

Enfield and District. Both these clubs were represented by members with some very fine launches and prototype craft, and one of the Bedford members had a most unusual model, a DUKW, complete with wheels! This boat performed extremely well, and although its shape would appear to be obviously unsuitable for steering, it scored twice in the steering event.

A nomination race, down the lake, was held first, a new departure was the placing of the steering flags at the end of the course and a special prize was to be awarded for the boat making the highest score, one run only was allowed. With so many fine boats present the nominations were very good indeed and the winner, Mr. Eltridge, with his famous paddle steamer, *Royal Sovereign* was first, his error being only 0.6 sec. in 76 secs. Mr. Hood of the Swindon club made the best score, 3 points, in the steering part of this event.

Results :	Error
1st Mr. Eltridge (Victoria)	
<i>Royal Sovereign</i>	0.6 sec.
2nd Mr. Curtis (Victoria)	
<i>Micky</i>	0.3 sec.
3rd Mr. Kirkham (Swindon)	2.8 sec.

(Results by per cent. error)

The two "C" class events were next run, both over 500 yds. and although several boats were present in each class, only one competitor succeeded in completing the course in either of the two races. In the "C" class event, Mr. B. Miles was unlucky not to complete the distance on both attempts, and his class "C" (restricted) boat, which is new to regatta work, looks very promising. Mr. G. Stone (Malden) with *Lady Babs II* had a similar fate befall him, capsizing on one occasion and being unable to get away on the other starts. The boat competing in this event was one of the miniature craft of the Kingsmere club (55.5 sec.), belonging to Mr. Walton, who thus became the only prize-winner in the "C" class event.



The unorthodox twin-hull design of Mr. Stone's "C" class boat, "Lady Babs II" is clearly seen in this photograph

The steering competition followed, over a longer course than is usual for Victoria Park. This fact seemed to upset several boats which have made quite a reputation for steering. It proved, however, a most interesting event, the result being in doubt until almost the last boats to run.

Results :

	Points
1st Mr. J. Benson (Blackheath) <i>Comet</i>	11
2nd Mr. W. Gates (Victoria) <i>Squib II</i>	8
3rd Mr. Shepherd (Enfield and District) <i>ED1</i>	6

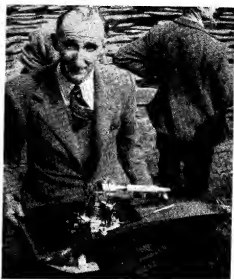
Events 4 and 5, ran in quick succession, were 500 yd. races for "A" and "B" class boats. In the "B" class several competitors could not get started and only two completed the course, Mr. Jutton (Guildford), *Vesta*, and Mr. Stalham, of Kings Lynn, with *Tha II*, Mr. Stalham recording the best time.

Result :

1st Mr. Stalham (Kings Lynn)	
<i>Tha II</i>	26.5 sec. = 38.5 m.p.h.

The "A" class event proved a disappointment, no competitors getting a run in. Mr. Clifford's *Blue Sreak* stalled on each attempt he made to get her away, and the same thing happened to Mr. E. Clarke's *Gordon*.

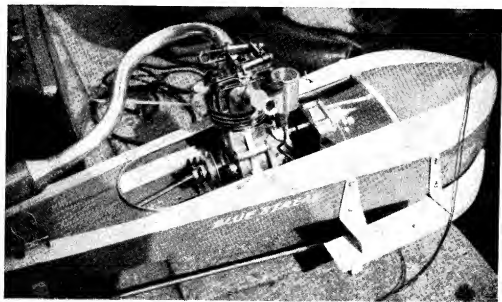
The day ended with a thrilling event not seen often at regattas these days—a relay race. Teams of three boats representing Blackheath, Victoria, Swindon and two scratch teams took part. The boats had to carry a baton, and the antics of the teams in retrieving this when some of the boats run off course were quite exciting. The Victoria



Mr. Stalham with his "B" class boat, "Tha II"

team proved the eventual winners, but the times were very close :—

Victoria (Messrs. Vanner, Mitchell, Curtis)	1 min. 44 sec.
Blackheath (Messrs. Benson, Rayman, Falkener)	1 min. 54 sec.
Swindon (Messrs. Hood, Kirkham, Walker)	1 min. 57 sec.



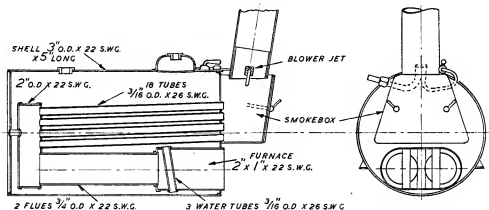
The 30-c.c. o.h.v. engine of Mr. S. H. Clifford's "Blue Sreak"

*UTILITY STEAM ENGINES

by Edgar T. Westbury

WHILE the centre-flue boiler is a long way ahead of the plain pot boiler in efficiency, it is still by no means all that can be desired for quick steaming and power/weight ratio. Perhaps its most important attraction from the model aspect is that it is very convenient for firing by means of the conventional form of "torch" type

flues are often added in the former case, so that the outside of the boiler shell also provides effective heating surface; this method, however, seems to have been rarely applied in model boilers. The use of return flues or banks of tubes is much more common, and in full-size marine practice has led to the evolution of the



Double-flue return-tube (Scotch) boiler, by British Industrial Model Services Ltd.

vaporising blowlamp, which has always been extremely popular, especially in model steamboats. It will burn quite well in a comparatively small diameter internal flue, where other methods of firing, including the use of solid fuel, would be very much at a disadvantage. But the centre-flue boiler not only incorporates a very large amount of metal for a relatively small evaporative capacity; it must also inevitably contain a large amount of water, as it is necessary to keep the centre-flue completely submerged. Even when the latter is placed eccentrically, well below boiler centre (as it nearly always is) this still applies. As a result, the bulk and weight of the boiler, plus that of the water it contains, is large in relation to power output. On the other hand, however, it should be pointed out that if used for purposes within its limited capacity, it is a very convenient boiler to manage, owing to its very large water and steam reserve, which reduces the tendency to violent fluctuation of pressure, and renders less critical the adjustment of feed supply or burner control. Messrs. Stuart Turner recommend a centre-flue boiler 8 in. long by $3\frac{1}{2}$ in. diameter for steaming a single-cylinder double-acting engine $\frac{3}{4}$ in. bore by $\frac{1}{2}$ in. stroke.

In the attempt to increase efficiency of internal-flue boilers, many expedients have been tried out, both in full-size and model practice. External

well-known Scotch boiler, which has been the most popular of all boilers for merchant ships, at least until quite recent years. Boilers of this type have been used with very fair success in model steam plants, though their advantages over the plain centre-flue boiler have not been definitely established, as the tubes cannot be made to true scale proportion, and the additional heating surface they provide is not comparable with that of the full-size boiler. I am personally of the opinion that while the construction of a model Scotch return-tube boiler would be well worth while in a plant intended to be a representative prototype model, its practical advantage is somewhat dubious.

Water-tube Boilers

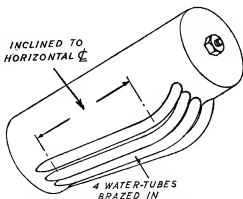
Boilers of this type offer more attractive possibilities for reducing the bulk and weight of plants, and in model sizes at least, are fairly easy to construct, though full-size boilers of this type provided very formidable problems in this respect when they were first introduced. At present, as is well known, water-tube boilers are the only type seriously considered for really large plants working at the highest pressures, and they enable the utmost economy and power/weight ratio to be obtained under these conditions.

One of the simplest and most successful model water-tube boilers was that introduced many years ago by Mr. Fred Smithies. It consists of an addition to the plain cylindrical pot boiler,

*Continued from page 733, "M.E." June 16, 1949.

in the form of a small number of looped circulating tubes in the underside of the boiler shell, thereby increasing the heating surface to a very substantial extent, and also establishing a path for the rapid circulation of water, which is essential to a high rate of steam generation if priming is to be avoided. In the original design of this boiler, it was considered essential to arrange the main length of the tubes to run obliquely, to assist in setting up a thermosyphon system of convection current. In view of the very small actual "head," or static pressure difference between the highest and lowest points in the tubes, however, it is by no means certain just how much this helps circulation, and many boilers have been made without the oblique run of the tubes, apparently with equal success. But as it is almost as easy to fit them as prescribed, and it often works out conveniently for the installation of the boiler in a locomotive, or firing arrangements in other cases, it is as well to do so "on the off chance."

Most designers of small boilers are agreed that there is a minimum size of fire- or water-tube, below which the skin friction of gas or water passing through the tube becomes so great as to interfere with or even completely stop circulation under the relatively feeble urge of convection currents. This effect becomes more serious as the rate of circulation is increased, and is found even in full-size boilers, so that it is becoming increasingly common to adopt measures for forced circulation by means of rotary pumps. This expedient is hardly practicable, or potentially profitable, in a model, so that it is desirable to use a small number of large tubes rather than

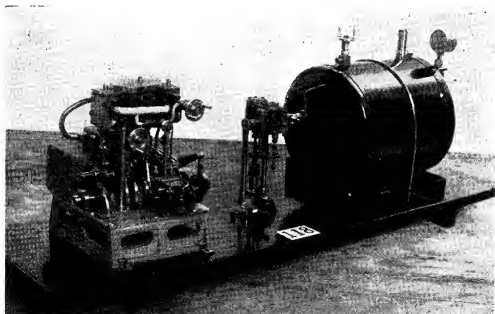


Pot boiler with bank of water-tubes on the underside, in the manner originated by Mr. Fred Smith's many years ago

the theoretically more efficient large number of small tubes. I have found that $\frac{3}{8}$ -in. o.d. tubes, with thin walls, not thicker than 22-gauge, are advisable for small Smithies-type boilers, and it is rarely possible to get more than half a dozen of them in a small boiler shell without undue crowding.

I shall probably be told by many constructors that they have used much smaller tubes with this with complete success. It is, however, uncertain to what extent circulation takes place in such cases, and observation will show that very small tubes often boil dry and even become

(Continued on page 810)



A very fine miniature model steam plant, comprising twin condensing engine, direct-acting feed pump and Scotch type boiler, by Dr. T. Fletcher, of Bradford

Steam Cylinder Passages

by K. N. Harris

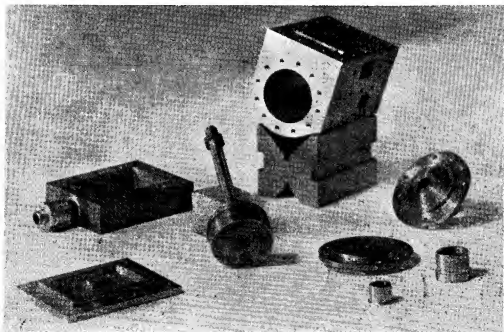
Notes on a method of assuring their adequacy
in small-sized engines

THE principles and methods to be described are not original, neither are they new; they were described in *THE MODEL ENGINEER* about 45 years ago by the late Henry Lea, M.I.C.E., a craftsman of the first order and a sound and clever engineer to boot.

One of the more awkward practical problems that the constructor of small steam engines runs up against is the production of satisfactory passages between port face and cylinder barrel, and to a less degree, between port face and exhaust orifice. I refer, of course, to engines of a size to make the satisfactory coring of these passages impossible, or at least extremely difficult.

There is a contention that passages may be much smaller than ports in cross-section, and in support of this thesis, it is pointed out, quite truly, that when the valve gear is linked up, the port is only very partially opened to steam and, therefore, the small passage is adequate. On the face of it, this sounds logical, but it overlooks the fact that, although the passages in question are

almost always referred to as "steam" passages, they are, for 50 per cent. of the working cycle, acting as exhaust passages, and, with a normal valve and valve gear, the port is fully opened to exhaust at any practical setting. If it is desirable (as it indubitably is) to provide an exhaust port and passage of more than twice the steam port area, then it does not seem sound policy to restrict the passage through which the steam has to make the first part of its journey to an area of something around one-fifth of this area, and on top of that to send it round a couple of sharp cornered right-angled bends on its way and at the same time to construct the passages that they offer an enormously increased surface as compared with a single passage, thus increasing skin friction. This practice is diametrically opposed to all accepted steam engine theory and practice, as it has developed over a period now close on two hundred years. In 45 years' practical engineering experience, much of which has been spent amongst reciprocating steam engines,



Cylinder unit components

including both marine and locomotives, I have never come across one where the passage between port face and cylinder barrel was smaller in cross-sectional area than the port; mostly, they were slightly larger, though very occasionally the same size, never less.

This applied to engines with cylinders varying in bore from 72 in. to 2½ in., and I find it neither logical nor reasonable to believe that theory and practice developed and proved efficient over a very long period and accepted by highly qualified engineers of all nationalities should become inapplicable at some hypothetical and arbitrary point below 2½ in. bore.

However, even in model sizes there is ample

tractive effort continuously at 6½ m.p.h. This is really a most extraordinary performance, as it involved a rotational speed of around 950 r.p.m. and a *mean effective pressure* of no less than 65 lb. per sq. in.; and further, the boiler had no difficulty in supplying steam. It has always struck me that insufficient attention was paid to this most outstanding piece of model locomotive engineering and to the principles and methods underlying its achievement. Furthermore, he was able to use an exhaust nozzle (of the multi-jet type) having a total area equal to one-thirteenth of the cylinder bore; the more usual figure for modern design gives nearer one-thirtieth, with results in added back-pressure which can well be

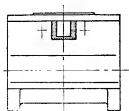


Fig. 1

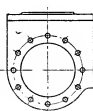


Fig. 2

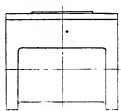
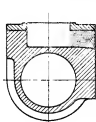
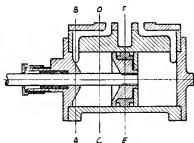


Fig. 3



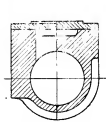
SECTION - EF

Fig. 4



SECTION - AB

Fig. 5



SECTION - CD

Fig. 6

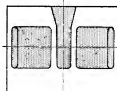
evidence to support the case for adequate passages. I will quote just a few: Mr. Lea's ½-in. scale single, based on one of the late S. W. Johnson's M.R. singles, was one of the most efficient small locomotives built (it was made around 1898!) and not a little of its efficiency was due to the design and construction of the cylinders, which provided for adequate passages; in passing, Henry Lea considered these a necessity for any approach to real efficiency in a model.

Some years later the late Henry Muncaster produced a series of designs in *THE MODEL ENGINEER* of high-speed engines, all of which embodied ample passages of easy contour; one of these I made up, and an excellent working job it was too, much more efficient than the commercial sets of similar size having much smaller passages. Mr. C. M. Keiller described his work with a 2½-in. gauge, ½-in. scale locomotive of his own make, in which he went to considerable trouble to provide most ample passages right from regulator to exhaust, and in which he did all the streamlining possible. The results were startling, with a pair of cylinders only ½ in. × 1-in. and 2 ⅝-in. wheels, he produced 7 lb.

imagined. (See *THE MODEL ENGINEER*, 15/6/39, for full details.)

When the Willoughby-Gentry design for the 7½-in. gauge 0-4-0 tank engine "Midge" was published, it was criticised on the grounds that the cylinders were too small. The late G. S. Willoughby, in a comprehensive and carefully-reasoned reply, drew particular attention to the fact that from regular port to exhaust nozzle, all steam and exhaust ways were of

ample cross section, and that in such circumstances the cylinders specified would produce all the power the weight of the engine could absorb. In the upshot, this proved to be right; for, without exception, engines built to this design are first-class performers and possess more than ample cylinder power. That, generally, is the case for adequate and easy contoured passages; and it



SECTION - GH

Fig. 7

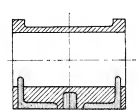
rests not so much on the question of inlet of steam, though this aspect, too, is important, but upon freedom of exhaust, which is more important.

It is desirable to keep clearance, or "dead space," down to reasonable limits, though with properly designed valve-gear, this dead space or clearance does not have to be filled with live steam at every stroke; nor would such live steam as does go to fill these spaces be totally wasted; first, compression ensures that these spaces do not have to be completely refilled with live steam at each stroke, and, secondly, such live steam as is required by way of make-up serves by its expan-

Here are his stated requirements:—

- (1) Smallest clearance volume possible with needed port area.
- (2) Smallest area of port walls surrounding this clearance volume.
- (3) Shortest possible path for the steam and as close to streamlined passages as possible.
- (4) Smallest valve with which the needed areas of port opening and exhaust passage can be obtained.
- (5) Least possible contact of inlet steam with parts which are cooled by exhaust.

Now as to constructional methods. Figs. 1-6 show details of a pair of locomotive cylinders



MILLED-OUT PORTIONS SHOWN DOTTED

Fig. 8

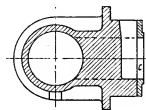


Fig. 10

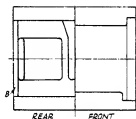


Fig. 12

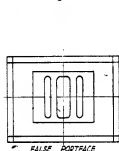


Fig. 9

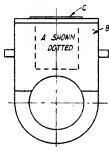


Fig. 11

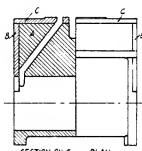


Fig. 13

NOTE A.B.&C. PEGGED & SILVER-SOLDERED

sion after cut-off, slightly to raise the average pressure during the expansion period, and so the average m.e.p. throughout the stroke.

The advantages gained through free admission and, even more, by free exhaust, which are obtained by the provision of decent sized streamlined passages, far outweigh any minor losses caused through the very slightly increased clearance space involved. In a full size locomotive, the total clearance volume will vary between around 4 per cent. and 5 per cent. for a modern poppet-valve cylinder up to as much as 10 per cent. for a piston- or slide-valve cylinder. In the cylinders described, this figure is about 3 per cent., which is not bad for a model.

In this general connection some remarks of Abner Doble's on the *desiderata* for cylinder design for efficient small engines are well worth quoting, for nobody has had more experience in this line, or has produced more efficient small reciprocating engines. Some of these had cylinders as small as $1\frac{1}{2}$ in. bore.

$1\frac{1}{2}$ in. bore by $1\frac{1}{2}$ in. stroke which I have recently completed.

The cylinders themselves were a pair of castings, intended originally for a two-cylinder $\frac{1}{2}$ -in. scale "Royal Scot," I believe, of the slide-valve type, which I happened to have lying around.

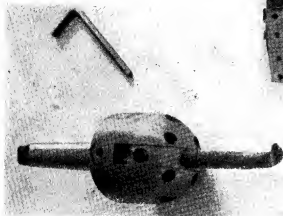
First, quite a lot of metal had to be removed from what was the normal port-face and the bolting-face, and, after marking out, this was done on a horizontal milling-machine with the vertical attachment fitted, using a $\frac{1}{2}$ -in. diameter end-mill. Secondly, the passages were marked out as shown in Figs. 7, 8 and 9. They were milled out, using a $\frac{1}{2}$ -in. diameter end-mill with a rounded-off end for the recesses, and a $\frac{1}{4}$ -in. mill for the passages through to the cylinder barrel. The portions of the exhaust passages shown dotted in Figs. 1 and 4 were subsequently filed away; whilst it would have been quite possible to have completed these by milling, the set-ups involved would have taken far longer than did the quite simple filing operation. The rounding-

off of the inner edges of the passages leading to the cylinder barrel was done with chisel and file.

Next, the false port faces were made from hard gunmetal machined to $5/32$ in. thick, and the ports themselves carefully marked out and formed by drilling and filing; note that their ends are left rounded, and not squared out, this tends to prevent scoring of the valve. The mating-faces of the cylinder and false port face were scraped to surface plate, two dowel pins were fitted, a tight fit in the cylinder block and an easy fit in the false port face. A shim of "Easiflow" 0.006 in. thick was cut to match the cylinder face, the portions over the passages being cut away and holes cut for the dowel pins. A thin paste of "Tenacity"

operation is carried through with a "Creed" adjustable boring-head, a most valuable tool which can be adjusted to take out any desired cut; it is illustrated in the photograph below. A fine automatic feed was used and, for the finishing cuts, was reduced to around 400 to the inch. The result was a truly circular, smooth and parallel bore.

The cylinder ends were machined on a mandrel, and it is best in a job of this sort to use a steel mandrel highly finished and greased before use,



Cylinder, showing port face



Left—"Creed" adjustable boring-head; shank is No. 2 M.T.

flux was made up and painted over the cylinder port face, the shim laid in place and the underside of the false port face also given a coating of "Tenacity" flux and placed in position. A length of 2-in. diameter brass rod about 5 in. long was taken along with the cylinder, and a temporary muffle made with firebricks, the cylinder being carefully supported port face up. The brass block was placed on top of the muffle so that it got thoroughly heated by the gas-torch flame and the whole cylinder assembly brought up to a dull-red heat, when the brass block was placed on top of the whole issue, gently tapped (probably an unnecessary precaution) and left to cool out black, when it was immersed in pickle and left for an hour. The result was a perfect joint which, when cleaned up, was very difficult to detect with the naked eye.

The next job was to bore the cylinders; this was purposely left until after the soldering operation, so as to avoid any remote possibility of distortion. The actual boring was carried out on my 4-in. Spencer lathe, with the cylinders set up on a special packing-block (on their bolting faces), itself mounted on the boring table (the boring table on this lathe is a separate attachment which replaces the top-slide, when required).

Note particularly that, when using a boring table, the cross-slide must be effectively locked and there must be no sign of slackness in the saddle; if these precautions are not observed, an oval bore is the inevitable result. The boring

which avoids the risk of scoring the cylinder bore. Be sure both are really clean, because, if the mandrel is a good fit, there is no need to drive the cylinder on hard; it will drive against the cut quite satisfactorily without such treatment.

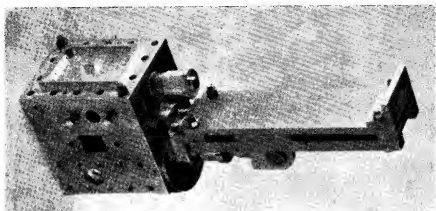
The next operation was to mill a rebate around each port face, so that the valve worked on an isolated area which could at any time be re-surfaced without having to reduce the whole surface or to alter the position of the steam-chest bolting-face relative to the cylinder bore. This operation was carried out by end-milling, after which the actual port face was hand scraped to surface-plate.

The three other photographs show the cylinders in various stages of assembly with their steam chests, valves, covers, pistons, etc.

The pistons are of phosphor-bronze turned after mounting on their rods with the rods held in a collet chuck. As will be seen, they are built up to enable the rings to be mounted without stretching and risk of distortion.

The rings were made from a chrome-nickel steel by the usual methods, and are $5/64$ in. wide by about $3/64$ in. thick at the thickest part; they are only very slightly eccentric.

The steam-chest covers were milled out and are made to take a lagging cover with an effective amount of lagging, a matter well worthy of attention, as there are definite savings to be made along this line. Actually, the only directly exposed surface of any size is the back cover, as a sheet of



Cylinder assembly with slide bars and crosshead. Note large steam inlet (circular) and exhaust (rectangular) openings

non-conducting material is fitted between bolting face and frame, a practice which Mr. Keiller found effective in sizes as small as $\frac{1}{8}$ -in. scale.

The large flat-bottomed hole seen in photograph in the bolting face is for a steel dowel which fits in a corresponding hole in the frame and serves effectively to relieve the holding studs of a large proportion of shearing stress. In passing, the fastening of cylinders to frames should be by well-fitted set-screws, bolts or studs, counter-sunk-headed screws should *not* be used in shear; they always have a tendency to work loose, particularly under alternating reversed stresses.

It should be noted that the exhaust cavity in

the slide-valve is of ample size, just one more link in the "free passage" chain. The slide-valve is built up and silver-soldered together; this method ensures easily obtained accuracy with exhaust cavity size, as it can be checked visually as well as by mensuration.

The Figs. 10-13 show the same general principle carried out a little more elaborately to take care of the case in which the port face must be at some considerable distance from the cylinder bore, and to improve streamlining.

This makes for even greater efficiency, but it does involve considerably more complication in milling set-ups, and in detail work in general.

Utility Steam Engines

(Continued from page 805)

red-hot under these conditions. Nevertheless, the tubes may still play their part in increasing heating surface, provided that they do not fail mechanically through overheating—a very real risk, by the way. The conductivity of heat in small boilers is very good, as compared with that in large ones (another thing which does not work to scale) and much of the heat picked up by the "dry" tubes can thus be effectively utilised.

Many years ago, Mr. James Crebbin made some experiments with small boilers which indicated that any projections on a boiler shell, exposed to the furnace of flue heat, would contribute to efficiency, and it was found that by brazing small copper rivets, with projecting shanks, into the underside of a small pot boiler, an efficiency comparable with that of a well-designed fire- or water-tube boiler could be obtained. This points to possibilities in small "hedgehog" boilers—it may be observed that something closely approaching this form of design has been successfully adopted in full-size practice—or in providing boilers with fins like the cylinders of i.c. engines. It should, however, be noted that it is one thing to increase heating surface, and another to make a boiler capable of working at high steaming rate; for the latter, an ordered system of circulation is absolutely necessary, and the ebullition produced in a plain pot boiler in these

circumstances may render it unmanageable.

Many model designers have sought to emulate the design of successful full-size water-tube boilers such as the Yarrow or Babcock types, with varying success, according to details of design or execution. Generally, however, better success has been attained by designing model boilers from first principles, having regard to the particular difficulties which arise in scaling down the water-tubes. A very successful example is the Stuart twin-drum marine boiler, which was obtainable before the war in two sizes, the "Major" having drums $1\frac{1}{2}$ in. diameter by $7\frac{1}{2}$ in. long, and the "Minor," drums $1\frac{1}{2}$ in. diameter by $6\frac{1}{2}$ in. long. These boilers were designed for spirit firing, but their output could be considerably increased by more efficient heating. Another excellent boiler was the Blakeney type described in *THE MODEL ENGINEER* before the war, in conjunction with a very efficient spray atomising burner operated by steam pressure.

In view of the relatively small water capacity of water-tube boilers, they demand much more careful attention to the feedwater supply than the centre-flue type, and show immediate response, by fluctuation of steam pressure, to variations in the furnace temperature.

(To be continued)

*The Design and Construction of Small Power Transformers

by A. R. Turpin

THE secondary winding is wound on the same way as the primary except that if the wire is thicker than 18 s.w.g. it is as well to revolve the chuck by hand, and you may have to resort to a flat piece of wood and a mallet to make the thicker gauges lie neatly. It is as well, in this

there until it ceases to bubble, the heat is then turned out under the pot of wax which is allowed to cool somewhat so that the wax is drawn into interstices of the winding; the bobbin is then removed and allowed to drain. Unless a proper oven is available, shellac is not recommended,

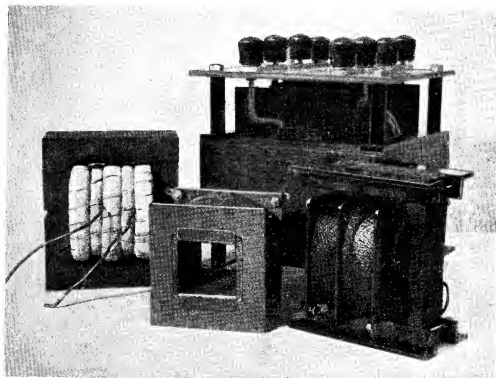


Photo No. 2. Three different methods of constructing small power transformers, and a wound bobbin ready for mounting on a core

case, to bring up the back centre, and also have the reel of wire directly in line with the bobbin.

The transformer may be finished off by two more layers of empire tape, and a strip of rexine if you want to make a neat looking job of it. The writer has never bothered to impregnate his windings, except when cotton-covered wires are used and then the whole bobbin is placed in really hot paraffin wax, and allowed to remain

because if the baking is not carried out correctly it can be both detrimental and dangerous.

The windings having been completed and waxed, the core can be assembled by pushing the stampings through and around the bobbin from alternate sides, so that the joints alternate. It should be pointed out here that it is imperative that the joints should butt perfectly, because air has about 2,000 times more reluctance than the iron, and a space of only 1/200 in. is the same as increasing the length of the core by 10 in.; although this does not apply to the same extent

*Continued from page 779, "M.E.," June 23, 1949.

when the stampings are assembled from alternate sides, as the adjacent lamination offers an alternate path for the flux, but nevertheless, the efficiency can be greatly reduced if care is not taken over this point.

Photograph No. 2 shows a number of transformers and various methods of clamping the stampings and fixing the terminal blocks. It should be mentioned here that when connecting, say, 16 s.w.g. or thicker wire to a terminal, it is not advisable to use the ordinary soldering

turn. It may be found difficult to watch this and proceed with the winding of the coils at the same time, but it should be a simple matter to arrange for the handle of the leadscrew to operate a sounding device so that each revolution can be heard and counted.

To wind a sectional coil, it is necessary to construct a former as shown in Fig. 4. This is constructed of wood, and consists of two pieces slightly larger than the diameter of the finished coil, and a centre-piece the width of the coil,

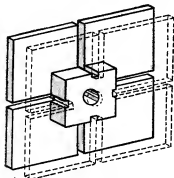


Fig. 4. Construction of former for sectional windings

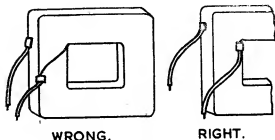


Fig. 5. Wrong and right way of making connections to former-wound coils

tags if local heating is to be avoided, they must be much heavier than those usually sold for, say, 2-B.A. size. A better plan is to solder the wire direct to the terminal shank for a length at least four times the diameter of the wire. Another point worth noting is that with the chuck revolving in the normal direction, the wire feeds on to the bottom of the bobbin, making it rather difficult to see what is happening, and if the reader is lucky enough to have a reversing switch he will find it a lot easier to have the chuck revolving in an anti-clockwise direction.

When fine wire is used, say, over 30 s.w.g. it will be found a rather tedious job winding this wire in even layers, and it is simpler if the section winding is used.

Section winding consists in winding the primary and secondary in a number of sections, usually two or three, and these sections are two or three times deeper than they are wide; each layer is not wound on absolutely evenly, and there is no need to interleave each layer because the potential difference between them is much less than in "bobbin"-wound coils. It is, however, necessary to have some kind of mechanical counting device, as it is not possible to count each turn individually as it is by the previous method. A "Veeder" type counter is the best plan, and this can be fitted to the rear of the mandrel or any other convenient place. Failing a counter of this type the leadscrew can be used for the purpose. If the gear train is set up as if to cut, say, 64 t.p.i., then one revolution of the feedscrew hand-wheel will indicate eight turns on an 8 t.p.i. leadscrew, and if the hand-wheel periphery is divided by chalk marks into eight even divisions, each division will indicate one

and about $1/32$ in. larger than the cross section of the iron core; these parts are all rectangular in shape. A centre hole is drilled in all three to take a bolt of convenient diameter, and the three pieces bolted together. A slot is now cut down each side that that it just cuts into the centre-piece to a depth of about $1/8$ in.

A small wood-screw is screwed through all three pieces to act as a registration pin when the former is re-assembled from time to time. The corners of the centre-piece are slightly rounded and the inside edges of the cheeks smoothed and chamfered so that the fine wire will not catch on them.

Wind a strip of thinnish paper round the centre-piece to facilitate the eventual withdrawal of the coil from the former, and chuck it in the lathe by means of the end of the bolt, which should be long enough for this purpose. The set-up is the same as for bobbin winding, except that the leadscrew is not used to feed on the wire; instead, the top slide is moved slowly backwards and forward to feed on the wire as evenly as possible.

When the required number of turns have been wound on, the former is removed from the lathe, and needle-threaded with stout twine passed through the grooves at the bottom of one of the slots in the former, and the two ends of the twine tied over the wire, this procedure being repeated for each of the four slots. Now place the former in hot paraffin wax and let it remain there until it ceases to bubble, and then drain and allow to get quite cold.

This latter procedure is not primarily for the purpose of increasing the insulation, but to hold the turns in shape when the coil is removed

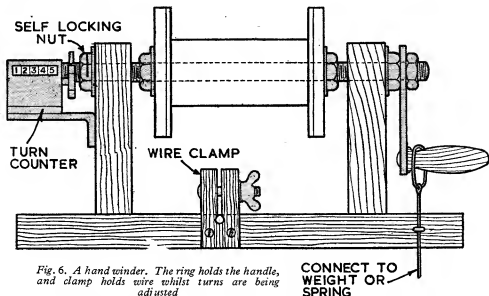


Fig. 6. A hand winder. The ring holds the handle, and clamp holds wire whilst turns are being adjusted

from the former, which can be now carried out. Remove the registration screw, unbolt the former, and then carefully remove the cheeks; the centre-piece can then be pushed out from the centre of the coil.

Cut two 6 in. lengths of thin flex and solder one end of each length on to the beginning and finishing ends of the coil cover with a small piece of oiled silk and fix to the coil with a dab of Chatterton's compound, as shown in Fig. 5; and as shown in this figure, there is a right and a wrong way of doing this. The correct way is such that at no point does the unprotected wire touch or cross those of high potential. The coil is now wound with two layers of empire tape, and this may result in a slight distortion of the shape of the coil. It is well to press it gently between boards, and then push it over a tapered piece of wood the same size as the centre-piece of the former less the thickness of the binding tape; this done, the section is completed and the next can be wound in the same way.

When all the sections are completed, cut a strip of leatheroid, the width of which is the same size as the length of the iron core, bend this into a rectangular tube and slide the finished coils over it; this is to prevent the sharp edges of the

laminations tearing the tape round the coils when the core is assembled, which may now be done.

Before clamping the stampings up, it is as well to test that each coil has been joined up in the correct sense even if the starting and finishing ends were marked when the coil was wound.

To test, connect all the primary sections in series, and then connect the mains across the the first section with a low-wattage lamp in series for safety. Measure the voltage across this section, and then across the first two, the latter reading should be approximately twice the first, if the reading is negligible the winding is reversed, and the connections should be changed. Connect across the third section, if any, and the reading should be three times the first, if only equal to the first, then the winding is reversed. With the mains connected across all the primary sections, make a similar test on the secondary.

Finally, for those not equipped with a lathe, Fig. 6 shows the design for a hand winder. When it is desired to adjust the turns, the ring is slipped over the handle which holds it steady, and the wire from the reel is clamped in the slotted piece of wood, so that both hands are free to make the adjustment.

Exhibition at Bognor

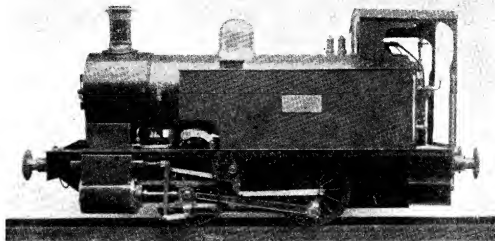
THE West Sussex Model Engineering Society announces that its third annual exhibition will be held at the St. John's Hall, London Road, Bognor Regis, from July 11th till 16th. The exhibition is to cover every phase of model engineering, and the competition section will be one of the chief features.

We have happy recollections of the previous exhibitions at Bognor Regis, and we have no

doubt that this year's show will prove to be at least as successful as its predecessors.

Other clubs and "outside" individual craftsmen are invited to take part by entering models in the competition or loan sections; and we are pleased to note a special appeal to young enthusiasts to exhibit their first or early efforts. Entry forms and full information from Mr. F. P. Sharwood, 48, Chichester Road, Bognor Regis.

TRADE TOPICS



DICK SIMMONDS & CO., of Erith, not long ago produced drawings, castings and parts for a neat 0-4-0 tank locomotive for 5-in. gauge; the engine is known as "Ajax," and we are not surprised to learn that it is rapidly acquiring popularity. We are pleased to be able to reproduce a photograph of a completed engine to show the generally pleasing appearance of this sturdy and powerful little unit. A stamped addressed envelope sent to the firm will be returned containing a descriptive leaflet giving interesting information about this attractive little engine.

Messrs. Simmonds have a small but well-equipped workshop at Erith, and when we were there recently we found a very fine "Maisie" and "Petrolea" as well as an "Ajax" under construction. The boiler work on all these was especially noteworthy.

The casting stores was remarkable for the enormous variety of the castings; we should think that castings for almost any of "L.B.S.C.'s" locomotives are to be found there, ranging from wheels of all sizes to miniature pump bodies for 2½-in., 3½-in. and 5-in. gauge engines.

The Ekco Solder Pencil

AN entirely new Ekco product, shown for the first time at the B.I.F., Olympia, is the Ekco Solder Pencil—a miniature soldering iron of special value in the making of miniature and sub-miniature electronic equipment. It is extremely neat in design, light in weight and practical in its application. It can be comfortably handled all day without overheating, and its power of consumption is very low either from battery or with transformer on mains opera-

tion. An outstanding feature is the quick-heating of the bit to soldering temperature from cold—only 50 seconds.



The product promises a revolution in soldering technique in many industries where fine work within close limits is necessary. At present, it is available to the overseas market only, but it will later be supplied to the home market, when full details will be announced.

The photo shows the handiness of the tool.

PRACTICAL LETTERS

The Double Slide-valve

DEAR SIR,—I was pleased to read Mr. H. W. Holmes's letter relating to the above.

I blame myself for not marking the drawing on page 520, "Diagram only," for it was never intended to be an accurate setting diagram. I endeavoured to set out a principle that enjoyed a period of popularity some years ago, and one reader has already written to me, recognising the same type of gear used on a stationary engine, and with which he had some interesting personal experiences. He tells me that the plant in question was well known for its low steam consumption, without loss of efficiency.

Mr. Holmes would be quite right about the interference with the exhaust event, and his suggested remedy takes the form of an extended cavity which is also the obvious and sensible one.

When I stated that the exhaust cavity should always take the form shown on the drawing, the inference was a general guide to valve design, and not peculiar to the design submitted, and the form of the cavity need not bear any relationship to the other parts of the valve. It is obvious that the provision of a shaped deflector such as this, must help the steam to get past an already tortuous path.

Taking the gear as a whole, many readers will recognise this as being nothing more than an inside-admission piston-valve gear, laid out in flat form, and capable of being set to exactly the same events. The only difference lies in the separate exhaust cavities instead of the one common space between the bobbin ends.

I am very surprised that not a single reader has pointed on me for my dissertations on the friction caused by the over large slide-valve. I let this statement go through as a "half truth," which it is in a way, but the facts are as follows: *The pressure on a slide-valve is proportional to the area of the ports it covers, and not to the total or gross area of the valve face.* To appreciate fully the significance of this, imagine a closed steam chest, having a port face but no ports cut, and a slide-valve resting on it. Pumping up the steam chest to 100 lb. pressure will not cause the valve to stick to the port face, whatever the area of the slide-valve. A mere pinhole through the port face, covered by the slide would perhaps provide it with enough adhesion to support its own weight.

The importance of the port area in relationship to the slide-valve working over it, is largely tied up with considerations of lubrication; for example, where lubrication is beyond suspicion, a large-area slide-valve will absorb less power when supported by an equally large area of oil film, than is the case with the small valve, *covering the same port area* but, therefore, subject to the same pressure as the larger-area valve. It will be seen that the small area of oil film is more easily crushed out from between the sliding surfaces.

There are still other factors entering into the problem of both lubrication and surface friction, one of these being the effect of the comparatively sharp edge of the valve for ever cutting away the existing oil film. It is quite good practice to re-

lieve the two "lap" edges of the valve, by slightly rounding them off, but the exact amount of this relief must be known in order to make the allowances for absolute hair-line setting.

Yours faithfully,
J. I. AUSTEN-WALTON.

Worthing.

Dendy-Marshall Valve-gear

DEAR SIR,—Mr. K. N. Harris' article, published some months ago, on the Dendy-Marshall valve-gear is very interesting, but there are one or two points that will bear a little elaboration.

First, as to its adaptability. Has it occurred to Mr. Harris that it is the ideal gear to use for poppet-valves actuated by rocking cams. Let the bell-crank fulcrum be the camshaft and a simpler arrangement would be very hard to find.

Secondly, the chuck for accurate setting of the eccentric and at the same time for correct length of eccentric-rod is that one may be able to reverse the engine (with crank on dead-centre) without moving the valve.

As to points four and five, I am not sure that Mr. Harris is not "barking up the wrong tree." It must be remembered that the travel forward of the slide pivot is greater than the travel aft of the slide pivot, due to the angularity of the eccentric-rod, and in practice, the easiest way to correct this is to fold the gear slightly back on itself, i.e. to make the angle slightly less than 90 deg. Similarly, with point five, it may be found that moving the fulcrum of the bell-crank up or down may have a lot to do with obtaining equal openings of the valve. I should certainly regard the 90 deg. angle mentioned as first approximations only, subject to revision before the setting-out is finally approved. It may be noticed that this form of error gives most trouble with the Hackworth gear where the eccentric-rod is short and the valve-rod long, and that in Joy gear it can be completely eliminated by attaching the vibrating link to the correct point on the jack-link.

Thirdly, Mr. Harris mentions the error due to up and down motion of the driving-axle. Well, something can be done by careful design. Let the eccentric (or return-crank) travel be made as long as possible so that the axlebox motion is a small proportion of that travel and the error will thereby be reduced.

With Hackworth gear, the Gilbert gear mentioned by "L.B.S.C." recently might be the solution; but what about using a "Cannon" axlebox as on some of the L.M.S. "5's" and erecting a proper motion-plate thereon to carry the slides or link pivots?

In a lecture at Leicester some time ago, Mr. Harris described a gear which he said he had only recently come across, which was actuated by a rod from the main crankpin and which was fairly closely related to one of Greenly's gears. I should be very grateful if he would submit a description of it to the Editor for publication.

Yours faithfully,
JOHN H. REYNOLDS.

Rugby.